WHAT IS CLAIMED IS:

1. A wireless fading-channel demodulator comprising:

a receiving-processing portion which receives and converts sub-array group analog communication signals that are received via M antenna sub-array groups, into digital input signals, multiplies the digital input signals by corresponding weighted vector elements, and sums the products for each sub-array group to generate M diversity-beamforming signals;

a signal magnitude and phase processing portion which multiplies the magnitude and phase of a representative digital input signal for each of the M sub-array groups by the corresponding one of the M diversity-beamforming signals and outputs the M products;

a final beam output portion which sums the M products output from the signal magnitude and phase processing portion and outputs a final output signal; and

a weighted vector calculation portion, wherein the weighted vector calculation portion:

calculates, from the digital input signals, a weighted vector that comprises the weighted vector elements;

selects the representative digital input signal for each sub-array group from among the digital input signals; and

calculates and outputs the magnitude and phase of the selected representative digital input signal for each sub-array group.

2. The wireless fading-channel demodulator of claim 1, wherein the receiving-converting portion comprises a plurality (M) of beamformers that each convert analog communication signals received from one of the corresponding M sub-array groups into the digital input signals and generate one of the M diversity beamforming signals using the digital input signals and the corresponding weighted vector elements;

and wherein each of the beamformers comprises:

analog-to-digital converters that convert L analog communication signals received via a corresponding one of the M sub-array groups into L digital input signals and output the L digital input signals;

multipliers that multiply the L digital input signals by the corresponding weighted vector elements and that output L products; and

an adder that sums the L products that are output from the multipliers, and outputs one of the M diversity-beamforming signals.

3. The wireless fading-channel demodulator of claim 1, wherein each of the M sub-array groups comprises a plurality (L) of antennas in a sub-array that receive wireless fading channel signals, and the spacing between the L antennas

in each sub-array group is smaller than the spacing between the M sub-array groups.

4. The wireless fading-channel demodulator of claim 1, wherein the weighted vector is calculated using the following equations:

$$u_m = [u_{m1}, u_{m2}, \ldots, u_{mL}]^T$$

$$R_m = E[u_m u_m^H]$$

$$w_{m,opt} = \frac{R_m^{-1} s_{m1}}{s_{m1}^H R_m^{-1} s_{m1}}$$

where $\mathbf{u}_{mL}$ denotes an L^th digital input signal of an m^th sub-array group, $E[\ ]$ denotes the mean value, $w_{m,opt}$ denotes a weighted vector for the m^th sub-array group, and s_{m1} denotes a steering vector based on the direction-of-arrival of a representative digital input signal from the m^th sub-array group.

5. A signal receiving system for mobile communications, the system comprising:

a plurality (M) of sub-array groups, wherein each of the M sub-array groups includes a plurality (L) of antennas in a sub-array and receives wireless signals via assigned wireless channels;

a radio frequency module unit that extracts analog communication signals from the received wireless signals and outputs the extracted analog signals as sub-array group analog communication signals; and

a wireless fading-channel demodulation unit that receives and converts the sub-array group analog communication signals into digital input signals, generates M diversity-beamforming signals using the digital input signals and weighted vector elements, and outputs a final output signal by using the magnitude and phase of a representative digital input signal selected for each of the M sub-array groups and a corresponding one of the M diversity-beamforming signals.

6. The signal receiving system of claim 5, further comprising a relay processor that processes the final output signal to relay wireless communications between mobile stations over the assigned wireless channels.

7. The signal receiving system of claim 5, further comprising a display signal output unit that processes the final output signal to output a display signal that drives a display device of a mobile station.

8. The signal receiving system of claim 5, wherein the wireless fading channel demodulation unit comprises:

a diversity-beamforming portion that receives and converts the sub-array group analog communication signals, which are received via M sub-array groups, into digital input signals, multiplies the digital input signals by corresponding weighted vector elements, and sums the products for each one of M sub-array groups, to generate M diversity-beamforming signals;

a signal magnitude and phase processing portion that multiplies the magnitude and phase of a representative digital input signal for each sub-array group by the corresponding diversity-beamforming signal and outputs M products;

a final beam output portion that sums the M products output from the signal magnitude and phase processing portion and outputs a final output signal; and

a weighted vector calculation portion wherein the weighted vector calculation portion:

calculates, from the digital input signals, a weighted vector that comprises the weighted vector elements;

selects one representative digital input signal for each sub-array group from among the digital input signals; and

calculates and outputs the magnitude and phase of each of the selected representative digital input signals.

9. The signal receiving system of claim 8, wherein the diversity-beamforming portion comprises a plurality of beamformers that each convert L analog communication signals received from one of the corresponding sub-array groups into L digital input signals and generate one diversity-beamforming signal using the L digital input signals and L of the weighted vector elements;

and wherein each of the beamformers comprises:

analog-to-digital (A/D) converters that convert the analog communication signals received via the corresponding sub-array groups into L digital input signals and output the L digital input signals;

multipliers that multiply each of the L digital input by a corresponding one of the weighted vector elements and outputs L products; and

an adder that sums the L products that are output from the multipliers, and outputs one of the M diversity-beamforming signals.

10. The signal receiving system of claim 5, wherein the spacing between the antennas in each sub-array group is smaller than the spacing between the sub-array groups.

11. A method for demodulating a signal transmitted over a wireless channel, the method comprising:

(a) receiving and converting sub-array group analog communication signals, which are received via M sub-array antenna groups, into digital input signals, multiplying the digital input signals by corresponding weighted vector elements, and summing the products for each sub-array group to generate M diversity-beamforming signals;

(b) multiplying the magnitude and phase of a representative digital input signal for each sub-array group by the corresponding diversity-beamforming signal and outputting the products;

(c) summing all of the products obtained in step (b) to output a final output signal; and

(d) calculating, from the digital input signals, a weighted vector that comprises the weighted vector elements; selecting one representative digital input signal from among the digital input signals for each of the M sub-array groups; and calculating and outputting the magnitude and phase of each of the M selected representative digital input signals.

12. The demodulation method of claim 11, wherein step (a) comprises: converting L analog communication signals received via each one of the M sub-array groups into L digital input signals;

multiplying each of the L digital input signals for each sub-array group by L of the corresponding weighted vector elements and outputting L products;

summing the L products for each one of the sub-array group and outputting one of the M diversity-beamforming signals.

13. The demodulation method of claim 11, wherein each of the M sub-array groups comprises a plurality (L) of antennas in a sub-array, and the spacing between the L antennas in each sub-array group is smaller than the spacing between the M sub-array groups.

14. The demodulation method of claim 11, wherein the weighted vector is calculated using the following equations:

$$u_m = [u_{m1}, u_{m2}, \ldots, u_{mL}]^T$$

$$R_m = E[u_m \, u_m^H]$$

$$w_{m,\,opt} = \frac{R_m^{-1} s_{m1}}{s_{m1}^H R_m^{-1} s_{m1}}$$

where $\mathbf{u}_{mL}$ denotes an Lth digital input signal of an mth sub-array group, $E[\ ]$ denotes the mean value, $w_{m,\,opt}$ denotes a weighted vector for the mth sub-array group, and s_{m1} denotes a steering vector based on the direction-of-arrival of a representative digital input signal from the mth sub-array group.

15. A signal receiving method for mobile communications, the method comprising:

(a) receiving wireless signals via a plurality (M) of antenna sub-array groups, each of which antenna groups includes a plurality (L) of antennas in a sub-array;

(b) extracting analog communication signals from the received wireless signals and outputting the extracted analog signals as sub-array group analog communication signals; and

(c) converting the sub-array group analog communication signals into digital input signals, generating M diversity-beamforming signals from the digital input signals and weighted vector elements, and outputting a final output signal generated by multiplying the magnitude and phase of a representative digital input signal of each of the M sub-array groups by a corresponding one of the M diversity-beamforming signals.

16. The signal receiving method of claim 15, further comprising processing the final output signal to relay wireless communications between mobile stations over the assigned wireless fading channels.

17. The signal receiving method of claim 15, further comprising processing the final output signal to output a display signal that drives a display device of a mobile station.

18. The signal receiving method of claim 15, wherein step (c) comprises:

(c1) generating the diversity-beamforming signals by multiplying the L sub-array group analog communication signals corresponding to each one of the M sub-array groups by a corresponding one of the weighted vector elements;

(c2) multiplying the magnitude and phase of a representative digital input signal for each sub-array group by the corresponding diversity-beamforming signal and outputting the products;

(c3) summing all of the products to output the final output signal; and

(c4) calculating the weighted vector, comprising (M x L) weighted vector elements, from the digital input signals; selecting M representative digital input signals from among the digital input signals; and calculating the magnitude and phase of each of the M selected representative digital input signals.

19. The signal receiving method of claim 18, wherein step (c1) comprises:

converting the analog communication signals into the digital input signals;

multiplying the digital input signals for each sub-array group by the corresponding weighted vector elements and outputting the products; and

summing the products for each sub-array group to output one of the diversity-beamforming signals.

20. The signal receiving method of claim 15, wherein the spacing between the L antennas in each of the M sub-array groups is smaller than the spacing between the sub-array groups.